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Mosquito-borne diseases—a new threat to Europe?

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Mosquitoes are responsible for the transmission of several pathogenic microorganisms to humans, causing mosquito-borne diseases, such as malaria, dengue, yellow fever, West Nile virus (WNV) disease, Chikungunya fever, and Rift Valley fever (RVF). Although there are numerous native mosquito species (e.g. *Anopheles* and *Culex* spp.) present and thus able to transmit pathogens in Europe, other mosquito species (e.g. *Aedes* spp.) have recently been introduced and become established in the continent. Among them, the tiger mosquito, *Aedes albopictus*, is probably the major threat to public health in Europe. The presence of these tropical species means that there is a risk of the appearance of autochthonous mosquito-borne diseases that have previously never or rarely been seen in Europe, acquired after importation from endemic countries [1].

In the current themed section of CMI, four articles describe the growing importance of mosquito-borne diseases in Europe. The first article concerns five invasive *Aedes* mosquito species that have already become established in Europe, resulting in known and potential risks of local transmission of rare pathogens. In the second article, an overview of different types of surveillance and data collection with assessments of mosquito-borne disease risks and trends is presented by European Centre for Disease Prevention and Control (ECDC) experts. The third article reports on some of the most relevant aspects of WNV human infection, which has caused numerous outbreaks during the last 20 years in Europe. The fourth article describes the relevance of RVF, a mosquito-borne zoonotic disease that affects both livestock and humans.

Schaffner *et al.* review five Asian aedine mosquito species that have been discovered in Europe. Since the introduction of invasive mosquitoes, above all *A. albopictus*, to Europe through the used tyre trade and lucky bamboo plants, populations have already become established locally, and are spreading further [2]. As well as competent vectors, exotic pathogens are also introduced by travel and trade [3]. Therefore, increasing concern was evident after the outbreak of Chikungunya fever in Italy in 2007 [4], and after confirmation of two autochthonous Chikungunya virus infections in southern France in 2010 [5]. The threat of involvement of this mosquito species in the transmission cycles of pathogens in the EU increased even more after autochthonous cases of dengue fever occurred in France and Croatia in 2010 [6,7]. However, dengue viruses are commonly transmitted by the anthropophilic mosquito *A. aegypti*, which was the vector implicated in the transmission of dengue virus during the recent expansive epidemic of dengue fever in Madeira in late 2012 [8]. The authors concluded that there is a risk of the emergence of exotic mosquito-borne diseases in the regions of Europe where *A. albopictus* or *Aedes aegypti* are present [9]. Therefore, constant surveillance of invasive mosquito populations is needed for prompt assessment of the potential danger of future outbreaks.

Besides vector surveillance, human disease surveillance is fundamental for the early detection of cases and for prompt implementation of control measures. In the EU, tropical mosquito-borne diseases are reportable communicable diseases, and are thus covered by epidemiological surveillance [10]. Zeller *et al.* describe an overview of different surveillance activities of the ECDC to provide all member states with estimations of mosquito-borne disease risks. They collect various information through the specific expert networks (European Surveillance System) and by event-based surveillance, with the intention of enabling early detection of potential public health dangers, allowing prompt and appropriate action. Through the laboratory network (European Network for Diagnostic of Imported Viral Disease), the ECDC provides continuous support for laboratory diagnostics in the accurate detection and characterization of mosquito-borne pathogens (e.g. Chikungunya virus, dengue virus, yellow fever virus, WNV, and RVF). Complementary activities, such as expert consultations, field missions, the preparation of guidelines and technical reports, and the production of updated maps on the current known distributions of mosquito vector species, represent additional ECDC programmes on mosquito-borne disease surveillance [11]. Finally, the authors emphasize the need for coordinated human, veterinary, entomological and environmental surveillance of mosquito-borne diseases in Europe.

During the last 20 years, WNV has become the most important mosquito-borne virus, being responsible for a

increasing number of outbreaks in humans and horses within the warmer regions of Europe [12]. WNV is naturally transmitted in an avian cycle by mosquitoes of the genus *Culex*. Humans and horses can also be infected incidentally, but are considered to be dead-end hosts [13]. In a brief review, Sambri *et al.* summarize the current epidemic situation of WNV in Europe, the clinical features, the available diagnostic tools, and possible preventive measures to control this rapidly expanding mosquito-borne virus. The largest human WNV epidemics occurred in Romania in 1996 and in the Russian Federation in 1999 [14,15]. Over the years, sporadic human cases or limited outbreaks of WNV disease have become more frequent in southern European countries, such as Italy, the Balkan countries, and above all, Greece. In addition, concerns were raised after several reports of WNV transmission related to blood transfusion, or via organ donation, were published [16]. The increasing number of WNF outbreaks could be associated with the emergence of novel virus strains with increased pathogenicity, and with significant temperature deviations during the summer months [17,18]. As there is no licensed vaccine for WNV available, the present preventive strategy is based on enhanced local disease surveillance, ECED risk maps, and proper implementation of control measures.

RVF, caused by the RVF virus, is a severe mosquito-borne zoonosis affecting humans and livestock. Epidemics are frequent in Africa, and are associated with severe health and economic consequences [19]. Owing to the intensified legal or illegal livestock trade, and probably in relation to climatic changes, RVF virus has recently spread to the Middle East and the Indian Ocean [20]. In the present themed section, Chevalier discusses the low probability of the introduction and spread of RVF in Europe. However, she emphasizes that RVF outbreaks may occur in areas with favourable eco-climatic conditions for competent mosquito vectors where a large population of naïve ruminants is present. In such a scenario, the first human cases would be recognized among farmers, veterinarians, and slaughterhouse employees [21]. Although surveillance and diagnostic methods are available, control and preventive measures are still limited. Therefore, there is an urgent need to develop more efficient surveillance and control tools, and to support coordinated monitoring programmes, particularly in the Mediterranean region, to enable prompt recognition of the threat of potential introduction of RVF virus into Europe.

Transparency Declaration

No potential conflict of interests exists.

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